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Historical Grey Seal Abundance and Changes in the Abundance of Grey Seal Predators in the Northwest Atlantic

Abondance historique du phoque gris et évolution de l'abondance des prédateurs du phoque gris dans l'Atlantique Nord-Ouest

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ABSTRACT

Grey seals have inhabited the north-western Atlantic for millennia. Estimates of grey seal abundance prior to the 1960s are vague, but clearly indicate that the species was considered rare during much of the early part of that century. Grey seals were once abundant enough to be hunted by indigenous tribes and by early European explorers. Although abundant enough to hunt, we have little idea of historical population size. Nevertheless, the current size of the grey seal population is the highest in the last century. Hunting can account for their rarity, but why have they increased so dramatically? A number of hypotheses have been advanced to account for the rapid growth, including release from predation by sharks and killer whales, reduced incidental bounty kill, increased ice-breeding habitat for pup rearing, and changes in the ecosystem favouring seals. Although none of these hypotheses can be completely discounted, reduce mortality in the bounty, increased breeding habitat and greater food availability must have all played a role.

RÉSUMÉ

Le phoque gris habite le nord-ouest de l'Atlantique depuis des millénaires. Les estimations sur l'abondance du phoque gris établies avant les années 1960 sont vagues, mais elles indiquent clairement que l'espèce était considérée comme rare pendant une grande partie du début du XX^{e} siècle. Le phoque gris a déjà été suffisamment abondant pour que les tribus autochtones et les premiers explorateurs européens le chassent. Même s'il est suffisamment abondant pour qu'on le chasse, on dispose de peu de données sur la taille historique de sa population. Néanmoins, la taille actuelle de la population de phoques gris est la plus élevée du dernier siècle. Certes, sa rareté peut être attribuée à la chasse, mais comment expliquer la forte augmentation de sa population? Diverses hypothèses ont été émises pour expliquer sa croissance rapide, notamment une moindre prédation par les requins et les épaulards, une réduction des primes liées à l'abattage, une augmentation des habitats de reproduction sur la glace pour l'élevage des jeunes phoques et des changements dans l'écosystème qui avantagent les phoques. Même si aucune de ces hypothèses ne peut être rejetée d'emblée, la réduction de la mortalité attribuable à la chasse, l'augmentation des habitats de reproduction et une quantité plus abondante de nourriture ont sans doute contribué à l'accroissement de la population.

INTRODUCTION

The number of grey seals (*Halichoerus grypus*) inhabiting eastern Canadian waters has increased dramatically in the past half century (Trzcinski et al. 2007). Estimates of grey seal abundance prior to the 1960s are vague, but clearly indicate that the species was considered rare during much of the early part of that century (Comeau 1945, Fisher 1950). Although rare during most of the early part of the last century, Lavigueur and Hammill (1993) reviewed that literature indicating that grey seals were once abundant enough to be hunted by indigenous tribes in the Gulf of St. Lawrence and Newfoundland and by early European explorers. They must have been abundant also outside the Gulf of St. Lawrence and were hunted off southwest Nova Scotia. Although abundant enough to hunt, we have little idea of historical population size. Nevertheless, the current size of the grey seal population is the highest in the last century or more.

Grey seals have inhabited the north-western Atlantic for millennia. Archeological data in the Quoddy region of the Bay of Fundy reveal grey seal bones dating from 2200-350 yr BP (Lotze and Milewski 2004) and further south grey seals have been found from about 4000-400 yr BP at archeological sites in Maine and Massachusetts (Eaton 1898 in Waters 1967). According to Chantraine (1980) extirpation of the walrus in the Gulf of St. Lawrence increased hunting pressure on grey seals as an alternative source of oil resulting in a large reduction in numbers throughout much of their range (see Lavigueur and Hammill 1993). By the turn of the last century, grey seals were rare enough that they were no longer the focus of directed hunting (Comeau 1945). Although not directed at grey seals, harbour seal bounties in both Canada and the United States undoubtedly resulted in further grey seal mortality, particularly in Canada, until jaws were required to collect the bounty on seals killed (Mansfield and Beck 1977).

It seems likely that hunting can account for the rarity of grey seals for the better part of a century, prior to the 1960s. But why the population began to increase in the early 1960s is not well understood. Brodie and Beck (1983) hypothesized that the increase in the size of the grey seal population during the 1960s might have been attributed to reduced shark predation caused by a decrease in shark populations as a result of overfishing and bycatch in the swordfish and other fisheries. They noted that these fisheries exploited mainly porbeagle (*Lamma nasus*), with lesser catches of blue (*Prionace glauca*) and shortfin mako sharks (*Isurus oxyrinchus*); the latter two species being more likely predators of grey seals.

Presumably because of their large size, grey seals have few predators in Eastern Canada or elsewhere throughout their range. Potential predators in eastern Canada include both marine mammals and sharks. Killer whales (*Orcinus orca*) and the walrus (*Odobenus rosmarus*) are known predators of pinnipeds and also certainly would have taken grey seals historically. However, the walrus species was extirpated in Atlantic Canada by the end of the 18th century (www.cosewic.gc.ca) and therefore could not have been a factor in the recent increase. Shark species that might be considered or are known predators of grey seals include the white shark (*Carcharodon carcharias*), blue shark and probably shortfin mako shark and Greenland shark (*Somniosus microcephalus*). Although porbeagle shark, identified by Brodie and Beck as a potential predator, was the focus of an intense fishery that resulted in population collapse (Campana et al. 2008), analysis of >1000 stomachs indicated no evidence of grey seals in the diet (Joyce et al. 2002). Therefore, they do not appear to be a predator of grey seals.

Killer whales are know to consume a variety of marine mammals, including pinnipeds such as the harbour seal (*Phoca vitulina* e.g., Baird 1994), but there is little information on either the abundance or diet of killer whales off eastern Canada. Grey seals are presumably taken by killer whales, but there are no data. Opportunistic sightings and a multi-year photographic catalogue of individuals has resulted in 363 sightings (singles and groups) between 1864 and 2007, with most being

recorded in recent years from June to September in the Newfoundland/Labrador Region, although this likely reflects observer effort (Lawson et al. 2007). Based on the photographic records, Lawson et al. (2007) estimated that there are at least 63 individual killer whales in Newfoundland and Labrador. Relatively few killer whale sightings have been recorded on the Scotian Shelf (perhaps due to low sighting effort) or in the Gulf of St. Lawrence (despite appreciable aerial and vessel-based, cetacean survey effort in recent years). Although it cannot be fully discounted, based on our current, but clearly sketchy, understanding of killer whale distribution and abundance, it seems unlikely that a reduction in killer whale predation on grey seals played an important role in the increase in the grey seal population in the Gulf of St. Lawrence and on the Scotian Shelf.

Estimates of trends in the abundance of shark populations in the northwest Atlantic are based largely on fisheries data. Baum et al. (2003) analyzed shark by-catches from logbook data from the U.S. pelagic longline fleets targeting swordfish and tunas in the Northwest Atlantic between 1986 and 2000. They found evidence for a 79% (95% CI: 59 to 89%) decline in white sharks abundance, a 60% (95% CI: 58 to 63%) decline in blue sharks and a moderate decline of mako sharks (mostly shortfin mako, *Isurus oxyrinchus*). There appear to be no estimates of the abundance or population trends of Greenland sharks in the Northwest Atlantic.

Although declining abundance of white and other shark species could have reduced predation pressure on grey seals, there are no studies of the diet of white sharks off eastern Canada to determine if grey seals are consumed or how this may have changed over time. There is circumstantial evidence from Sable Island of white shark predation on grey seals during the past decade or so (Lucas pers. comm.). This evidence takes the form of the pattern of wounding on surviving seals and the occurrence of injuries during the summer and fall when white sharks are more likely to be in the vicinity of the island. However, these data are not sufficient to estimate the level of mortality caused by white sharks and there are no data when the grey seal population was small and might have responded to a reduction in white shark mortality. Blue and mako shark populations also declined due to overfishing, potentially reducing grey seal mortality. However, studies of blue and mako sharks in the North Atlantic indicate that marine mammals (including seals) comprise a very small part of the diet (McCord and Campana 2003, Lopez et al. 2009).

Evidence of Greenland shark predation on grey seals also comes from observations on Sable Island over the past decade or so, of wounds that are thought to be caused by this species. Although hundreds of grey seal pups are known to have been killed each year for the past decade, presumably by Greenland sharks, it is not possible to determine what fraction of deaths are observed. Therefore, estimates of predation mortality or trends in this mortality over the past half century of increase in the grey seals population are not available.

Despite the evidence for white and Greenland shark predation over the past several decades, the fact that grey seals have been increasing near r_{max} suggests that the overall level of predation must have been small. We cannot exclude the possibility that predation by white and Greenland sharks or killer whales may have changed over time, but it seems unlikely that shark predation has been a significant factor in the dynamics of grey seals over the few decades. Although the release-from-predation hypothesis cannot be rigorously tested, it seems to have little empirical support.

Mansfield and Beck (1977) also speculated on the reasons underlying the increase in the number of grey seals. They noted that the change in the bounty system in 1949, when the presentation of jaws became mandatory, resulted in a reduction in hunting effort on grey seals and a corresponding increase in survival. Another hypothesis was that the reduction in the harbour seal population, as a result of years of bounty hunting, reduced competition for food. Harbour seals and grey seals do consume many of the same species and so the opportunity for competition does exist (Bowen and Harrison 1996, Bowen et al. 1993). Also, Bowen et al (2003) found indirect evidence for competition

between these species at Sable Island, although in that case harbour seals were being out competed by grey seals. Therefore, reduced competition may have played some role, but there a few data with which to test the importance of this factor. The third hypothesis was that construction of the Canso Causeway in 1955 increased the area and quality (i.e., stability) of ice habitat in Georges Bay used by grey seals for rearing offspring (Cameron 1962, Mansfield and Beck 1974) with a resulting increase in productivity. The fourth hypothesis, which Mansfield and Beck (1977) gave the least weight, is that the grey seal culling program in the Gulf of St. Lawrence resulted in emigration from mainland and ice-breeding colonies to Sable Island where, undisturbed, productivity increased.

Each of these hypotheses, along with reduced predation, may have contributed to the increased productivity and resulting increase in population growth rate, but testing these hypotheses is hampered by the lack of abundance estimates at all colonies prior to the 1970s and other relevant data. Nevertheless, reduced mortality caused by changes in the harbour seals bounty and an increase in the quality of habitat must have had a positive influence on grey seal dynamics. The effects of fishing and climate variability on ecosystem structure and function may also have had a positive influence on grey seal dynamics by reducing competition with large piscivorous fish, such as Atlantic cod (*Gadus morhua*), and thereby increasing food availability (e.g., DFO 2003, Bundy et al. 2009).

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